Pertanika J. Soc. Sci. & Hum. 25 (3): 1449 - 1472 (2017)

PERTANIKA JOURNALS

SOCIAL SCIENCES & HUMANITIES

Journal homepage: http://www.pertanika.upm.edu.my/

# Development of an Office Building Sustainability Assessment Framework for Malaysia

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## ABSTRACT

This paper presents a study aimed at developing a building performance assessment framework relevant to emerging/developing countries that allows evaluations on whether, and to what extent, sustainability is addressed in office building developments. Instead of simply adopting an existing building performance assessment framework, a framework developed through original work involving various relevant stakeholders in Malaysian building industry is presented. The process adopted a mixed-methods approach, particularly using exploratory sequential design i.e. a qualitative followed by a quantitative phase. The goal of the qualitative phase was to discover essential performance criteria through 1) literature review; 2) in-depth interviews; and 3) focus groups discussion. The performance criteria identified from the qualitative phase were brought into the quantitative phase via a questionnaire survey for the purpose of assigning their weighting levels. The tentative assessment framework was then presented to local experts for validation, and finally the Validated Comprehensive Malaysian Office Assessment (MyOBSA) framework is proposed. The framework covers all aspects of sustainability, thus allowing sustainability to be assessed in all phases of building developments, from pre-design to operational stages. This study demonstrates that any emerging/developing country shall be able to develop its own building sustainability assessment framework by taking into account relevant priorities of that country.

*Keywords:* Building performance assessment systems, emerging/developing countries, Malaysia, mixed-methods, office, sustainable building, sustainable development

ARTICLE INFO

*Article history:*
Received: 17 October 2016
Accepted: 07 June 2017

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ISSN: 0128-7702 

## INTRODUCTION

In responding to the need to reduce the environmental impact of new and older buildings and promote sustainable construction, a plethora of building performance assessment systems (BPASs) and tools have been developed. Many such BPASs are in the form of rating systems that measure how well or poorly a building is performing or is likely to perform against a declared set of criteria. Well-known rating systems in developed countries include BREEAM[1] (UK), LEED[2] (US), Green Star[3] (Australia), Green Mark[4] (Singapore), and CASBEE[5] (Japan).

Many BPASs in the developing/emerging[6] countries, including Malaysia such as Green Building Index (GBI) rating systems (2017) reflect those of developed countries. A comparative review conducted by Shari and Soebarto (2015) on nine existing BPASs from developed and emerging/developing countries (including Malaysia's GBI[7] rating system) revealed that most of them are inadequate for addressing the three pillars of sustainability (environmental protection, human well-being enhancement and economic development) as well as many non-environmental priorities in emerging/developing countries. This is despite the fact that there are differences in priorities between developed and emerging/developing countries in implementing sustainable development and construction (UN, 1992; Du Plessis, 2002).

The significance of the problem has prompted research into the development of an appropriate assessment framework that enables sustainability to be addressed and incorporated in office building developments, relevant to emerging/developing countries, and this study focuses on the Malaysian context. A BPAS encompassing all the three pillars are of paramount importance to the Malaysian context but the question is: what would be the nature and form of an assessment framework relevant to Malaysia, taking into account possible shortcomings in its implementation such as unavailability of data? This is the overarching question of this research.

The authors argue that the Malaysian Office Building Sustainability Assessment (MyOBSA) framework developed in this study can better serve the needs of various stakeholders in decision-makings in the building and construction processes throughout the life cycle of their projects (from pre-design to operational stages). It does not only take into account the quantifiable factors of environmental issues, but also and equally the qualitative factors of social and economic issues. The framework is effectively a checklist that provides an assessment to measure performance using

[1]http://www.breeam.com/
[2]http://www.usgbc.org/leed
[3]http://new.gbca.org.au/green-star/
[4]https://www.bca.gov.sg/green_mark/
[5]http://www.ibec.or.jp/CASBEE/english/
[6]According to Dow Jones Indexes, emerging countries (such as Malaysia) are countries that have not yet reached advanced or developed status but have outpaced their developing counterparts.
[7]http://new.greenbuildingindex.org/

a point scoring system. Points are achieved when established criteria and the level of compliance are fulfilled.

While one might wish to question the need to develop another building assessment framework, this paper argues that this need is not unusual. Countries such as Hong Kong, North America and Australia have two or more BPASs coexisting within the same market. Inevitably, debates have emerged either favouring the coexistence of systems or vice versa. On the positive side, Cole (2006, p.367-8) agreed on three points: 1) multiple systems in practice in the same country can act as a driver for innovation; 2) a single system is difficult, if not impossible, to address many conflicting goals and cater different stakeholder interest; and 3) a single system stagnates intellectual debate and creates a condition of market 'lock-in', particularly when the present system focuses on green issues rather than addressing broader considerations of sustainability; thereby constraining those who wish to extend the scope.

On the contrary, multiple systems might also confuse the market by sending mixed messages, requiring design professionals to be familiar with multiple assessment systems (Cole, 2006). This however can be avoided if an alternative system is introduced timely i.e. when the green building market has matured, primarily because by this time, green building community have started to become more cohesive and their differences of opinions began to become apparent (Cole, 2006). As such, this study hypothesised that as the building industry in Malaysia has become familiar with environmental issues, relevant industry players are ready for a more sophisticated inclusion of sustainability principles within the system. The alternative MyOBSA framework developed in this study is differentiated in such a way that it offers a qualitatively different scope.

This study is significant as it contributes to the development of a new model or approach appropriate for emerging/developing countries. Emerging/developing countries will ultimately have an appropriate basis relevant to their countries to create sustainable construction industries, alongside efforts in developed countries to achieve global changes necessary for the future.

The aim of this paper is to describe the MyOBSA framework that was developed based on the specific requirements identified in Shari and Soebarto (2015). It can be regarded as the final research outcome of the first author's previous research activities in the area (see Shari, 2011). In particular the paper seeks to highlight the rationale behind different choices made during each stage of the framework development process. Once the developed MyOBSA framework is described, the paper then concludes by setting out a few recommendations for improvement and future research.

## METHODS

Since sustainability and the framework are context specific, this study adopted a mixed-methods approach, particularly using the exploratory sequential design i.e. a qualitative followed by a quantitative phase. The intent of exploratory design is to use the results of the qualitative method to develop the second qualitative method (Creswell & Plano Clark, 2011). In other words, exploratory design serves "to generalize qualitative findings based on a few individuals from the first phase to a larger sample gathered during the second [quantitative] phase" (Creswell & Plano Clark, 2011, p.86). Specifically, data collection and analysis methods engaged in this study were conducted sequentially in four phases.

Phase 1 is the qualitative phase where the goal is to identify the most essential assessment criteria or indicators to be included in the MyOBSA framework. There is currently no sufficient data on the perception of building stakeholders about sustainable development and sustainable office buildings in Malaysia. A qualitative study is deemed to be a preferable approach to generate the essential data for analysis. This phase included 1) wide-ranging literature review; 2) in-depth, semi structured, open-ended interviews; and 3) focus groups discussion. In this phase, the literature review findings were synthesized to reveal the relevant assessment criteria (Shari & Soebarto, 2015), which were further refined in the second and third stages conducted with experts from various backgrounds of the Malaysian construction industry (Shari & Soebarto, 2012a, 2013).

The criteria identified and refined in the qualitative phase were then brought into Phase 2 (quantitative phase) for the purpose of assigning their weighting or importance levels. This phase involved a cross-sectional questionnaire survey in which more than 200 local building stakeholders participated. The qualitative and quantitative strands were then mixed or integrated in Phase 3 after both sets of data had been collected and analysed to propose the performance benchmark[8] for each criterion. The proposed benchmarks were then brought into the process of validation by local experts to examine their reliability in the current practice. Finally, in Phase 4, the proposed assessment framework, which includes criteria, weightings, and benchmarks, was applied on a local case study building to test its applicability (Shari & Soebarto, 2012b); hence, forming the basis for further refining the framework empirically and identifying any criteria with missing input data.

The overall flow steps of the research and the research questions used in each phase of the development process are presented in Figure 1. Further explanation of this figure and the summary of results from each phase are outlined next.

[8]A benchmark is a standard, or a set of standards, used as a point of reference for evaluating performance or level of quality. For example, one of the criteria/indicators under 'Local People and Employment' (one of the sub-issues under 'Social' Issue) is 'Use Experienced Local Design Teams". The benchmark for this criterion is "At least 80% of design teams appointed for the project are local companies who have had good track records in designing similar type of project".

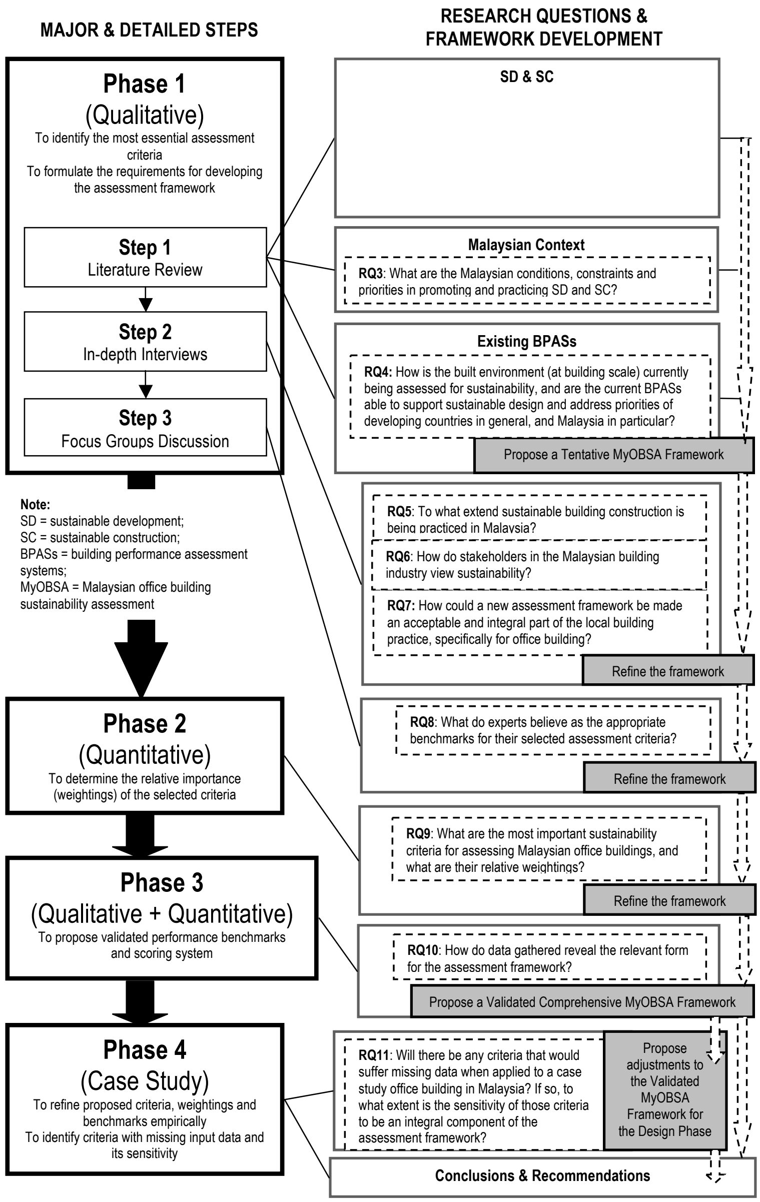


*Figure 1*. The overall flow steps of the research

## RESEARCH PHASES AND RESULTS

### Phase 1: Results from the Qualitative Phase

During the first stage, literature was reviewed to build a theoretical foundation for the research. The synthesis of overall findings is reported in Shari and Soebarto (2015). There were 102 assessment criteria identified at this stage and these were presented in a form of *Tentative MyOBSA* *framework*. A summary of this framework is presented in Table 1 (the finally selected assessment criteria under each sub-issue are shown in the discussion section).

Table 1
*Summary of the Tentative Malaysian Office Building Sustainability Assessment (MyOBSA) Framework*

| Sub-Issues | No. of criteria |
|---|---|
| S: Social | |
| EDU: Education & Awareness | 5 |
| COH: Support for Social Cohesion | 5 |
| ACC: Accessibility | 5 |
| INC: Inclusiveness of Opportunities | 3 |
| HUM: Human Health & Well-being | 14 |
| CUL: Cultural & Heritage Aspects | 3 |
| LOC: Local People & Employment | 6 |
| Sub-Total | 41 |
| Environmental | |
| ECO: Land Use & Impacts on Ecology | 6 |
| SRM: Supports Resource Management | 5 |
| AIR: Emissions to Air | 7 |
| LAN: Emissions to Land/ Solid Waste | 7 |
| EWA: Emissions to Water | 4 |
| ADJ: Impacts on Adjacent Properties | 4 |
| ENE: Non-Renewable Energy Consumption | 10 |
| WAT: Potable Water Consumption | 6 |
| Sub-Total | 49 |
| Economic | |
| TBL: Triple Bottom Line Accounting | 5 |
| EEF: Efficiency, Effectiveness & Flexibility | 7 |
| Sub-Total | 12 |
| Grand Total | 102 |

Following this step, in-depth, semi-structured, open-ended interviews were conducted to explore the extent of sustainable development practices in Malaysia, different views of sustainability among building stakeholders, and their primary concerns in pursuing sustainable office building development. The purpose of this stage is to define gaps that need to be bridged to promote sustainable building development and assessment in Malaysia. A total of 50 commercial building stakeholders practicing in Kuala Lumpur, Selangor and Putrajaya were purposely selected as participants. Invitations were sent via email, with 30 stakeholders agreed to be interviewed, consisting of 12 consultants, five developers/owners, three builders, four facility managers, and six regulators/policy makers. The purposive sampling, particularly judgement sampling, was used to provide the means to investigate a specialized population of stakeholders who have experienced in the relevant field for more than ten years. A sample size of 20 to 30 is deemed adequate to enable internal generalization in a qualitative study (Patton, 2015).

The data from the interviews were then analysed using content analysis. This is a process of identifying, coding, categorizing, classifying and labelling the primary patterns in the data (Patton, 2015), performed on individual cases and across cases. The qualitative results of this stage are reported in Shari and Soebarto (2012a, 2013). The results revealed that out of 102 criteria identified earlier, 65 criteria were confirmed, four refined and the remaining 33 were not cited by the interviewees. However, the interviewees suggested 13 new criteria which were then added, resulting in a total of 115 criteria (i.e. 65+4+33+13). The findings at this stage formed the basis of fine-tuning the tentative framework.

Subsequently, the framework was further refined through focus groups discussion. Focus groups are small groups of people, who possess certain characteristics, and who meet to provide data of a qualitative nature in a focused discussion (Krueger & Casey, 2015). Focus groups can be used to inform the development of questionnaires and interviews or later in a sequential mixed methods research study to help researchers better understand and interpret information and findings resulting from the earlier use of other data collection methods (Tashakkori and Teddlie, 2010).

Thirty-eight people participated in the focus group, consisting of 15 government officials/policy makers/regulators, nine academicians, seven design consultants, three contractors, two property developers, one project manager and one building materials supplier. They were experts in fields related to the built environment and knowledgeable in sustainable development in general and/or sustainable building in particular. Six focus groups were used, mainly based on six sustainability areas identified in the research which are (1) site planning and management (2) energy efficiency and system management, (3) indoor and outdoor environmental quality, (4) materials and solid wastes, (5) water efficiency and liquid waste, and (6) social and economic issues. Each group consisted individuals with similar expertise but from different professions.

Each focus group was asked to seek through consensus the essential criteria to be included in the MyOBSA framework by retaining, adding, omitting or modifying criteria identified in the framework developed. Whatever decision was made, participants were reminded to consider the following questions: 1) Should the criteria be included? Or is it relevant enough? 2) Should the text be modified?; 3) What might be the best indicator of performance?; and 4) Can the data for assessment be obtained at reasonable cost and effort? The groups were also asked to propose the minimum performance benchmarks or targets for the criteria derived above which are considered important and relevant to the local context.

Out of 115 criteria brought into the focus groups discussion (based on refinements made to the tentative framework), 106 criteria were agreed upon, while seven refined and two omitted. The results also discovered an additional seven new criteria, giving a total of 120 (i.e. 107+6+7) deemed appropriate to be brought into the next phase of development.

### Phase 2: Results from the Quantitative Phase

The goal of the quantitative phase was to determine the relative importance (or weightings) of the criteria, identified in the qualitative phase of the study. As Creswell and Plano Clark (2011) noted, exploratory sequential design is appropriate to be used to generalize qualitative findings to different samples.

The quantitative data was collected via a questionnaire survey, using a self-developed and pilot-tested instrument. The questionnaire form consisted of four parts: 1) background; 2) sustainability awareness; 3) sustainability preferences; and 4) expectations of MyOBSA systems; with the third part consisted of the core survey items. These items were performance criteria, grouped under seventeen sustainability sub-issues which were rated using four-point Likert-type scales where a score of "1" represents "Not important"; "2" represents "Less important"; "3" represents "Important"; and "4" represents "Very important".

The target population for this phase of the study included various groups of stakeholders within Kuala Lumpur, Selangor and Putrajaya, namely: 1) Corporate Members of the Malaysian Institute of Architects (PAM); 2) members of the Institute of Engineers Malaysia (IEM); 3) members of the Malaysian Institute of Planners (MIP); 4) company members of the Real Estate and Housing Developers' Association Malaysia (REHDA); 5) policy makers/regulators (from agencies/departments/sectors of five federal ministries identified as relevant to the study); and 6) other relevant construction industry players. Because the purpose of this quantitative phase was to arrive at broad generalizations of the population, different participants were selected in the quantitative follow-up stage. Furthermore, various stakeholder groups' participation is important to reduce the risk of bias.

A "systematic sample" with a random start (Bryman, 2008, p.172) was adopted to draw a sample from each sampling frame. This way, every nth element in the total list was chosen for inclusion in the sample after the first element is selected randomly within the first interval. On the other hand, no sampling method was employed for government agency employees since all identified members were sampled. The study adopted a mixed-mode data collection via group administration, mail and hand-delivery (later pick-up) methods.

Of the total 1000 questionnaires that were distributed, only 203 valid samples were received. Of which were 59 architects (29.1% of the total), 60 engineers (29.5%), 26 planners (12.8%), 20 developers/owners (9.8%), 13 policy makers/regulators (6.4%), and 25 others (12.3%). Accordingly, the final response rate was an acceptable 20.4%according to Akintoye (2000) who argued that the normal response rate in the construction industry for postal questionnaire is 20-30%. This seemed to be true in the Malaysian context judging from Othman et al. (2015), Al-Tmeemy (2011), Abdul-Aziz and Wong (2010), Shehu et al. (2014) and Majid et al. (2011) who obtained 24.4%, 22.8%, 19%, 15.7% and 6.8% respectively. In selecting the most important criteria suggested by respondents, it is considered reasonable that selection is based on their mean values after taking into account their respective standard deviation (SD). Since the questionnaire incorporated a 4-point Likert scale, the mid-point is then 2.5. In other words, the criteria that should be included in the MyOBSA framework must have a minimum mean of 2.5 or above, after taking into account their respective SD:

$$\text{Mean} - \text{SD} \geq 2.5 \text{ (rounded to 1 decimal point)} \qquad [1]$$

Subsequently, the eligible criteria as well as all Issues and Sub-issues are assigned with their weighting value which is the relative importance index (RII) constructed reflecting their level of importance using the formula (Kumaraswamy & Chan, 1998; Muhwezi, et al., 2014; Somiah, et al., 2015; Tam, et al., 2002; Tam, et al., 2007):

$$\text{RII} = \frac{\sum w}{\text{AN}} \qquad [2]$$

where $w$ is the weighting given to each issue, sub-issue or criterion by the respondent, ranging from 1 to 4 in which "1" is 'not important' and "4" is 'very important'; $A$ = the highest weighting, in this study $A$ = 4; $N$ the total number of samples; and RII the relative important index $0 \leq \text{RII} \leq 1$. Put differently, RII is calculated by dividing the mean of the weightings assigned by the respondents with the highest weighting i.e. 4.

However, since minimum means (mean minus the SD) were used as the basis of ranking the issues and sub-issues, as well as selecting the most important criteria, in addition to determining the RII of each issue, sub-issue and criteria. By using mean values, the resulted RII values were then transformed into three important levels: high (H) ($0.8 \leq \text{RII} \leq 1$), medium (M) (0.5

Table 2
*Descriptive statistics of the importance of criteria under the AIR Sub-Issue ($N_{all}$ = 203) – Example of how the criteria for "Emissions to Air" were selected*

| AIR: Emissions to Air | | | | | | |
|---|---|---|---|---|---|---|
| Criteria | N | Min | Max | Mean | SD | Min. Mean (Mean – SD) |
| GHG gas emissions from building operation | 203 | 2 | 4 | 3.50 | .59 | 2.9 |
| Pedestrian access to basic services | 203 | 1 | 4 | 3.34 | .65 | 2.7 |
| Connection to public transportation network | 202 | 1 | 4 | 3.29 | .70 | 2.6 |
| Proximity to public transport stops | 203 | 1 | 4 | 3.09 | .71 | 2.4 |
| Air pollution from site workers' accommodation | 202 | 1 | 4 | 3.11 | .80 | 2.3 |
| Proximity to residential zones | 201 | 1 | 4 | 2.85 | .72 | 2.1 |
| Bicycles and/or bicycle parking spaces | 203 | 1 | 4 | 2.80 | .85 | 2.0 |
| Minimum allowable parking spaces | 200 | 1 | 4 | 2.68 | .83 | 1.8 |
| Maximum motorcycle parking spaces | 203 | 1 | 4 | 2.53 | .89 | 1.6 |
| Valid N (listwise) | 197 | | | | | |

*Note:* 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; Shaded = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

≤ RII ≤ 0.8), and low (L) (0 ≤ RII ≤ 0.5) (Tam, et al., 2007). Since minimum means were used instead, the three important levels adopted are: high (H) (0.7 ≤ RII ≤ 1), medium (M) (0.5 ≤ RII ≤ 0.7), and low (L) (0 ≤ RII ≤ 0.5). Examples of deciding which criteria to be included or omitted in the framework are presented in Table 2, 3 and 4, representing one of the sub-issues under 'Environmental', 'Social' and 'Economic' issues respectively.

Table 3
*Descriptive statistics of the importance of criteria under the LOC Sub-Issue ($N_{all}$ = 203) – Example of how the criteria for "Local People and Employment" were selected*

| LOC: Local People and Employment | | | | | | |
|---|---|---|---|---|---|---|
| Criteria | N | Min | Max | Mean | SD | Min. Mean (Mean – SD) |
| Training opportunities for local people | 199 | 1 | 4 | 3.49 | 0.64 | 2.9* |
| Locally produced materials | 199 | 1 | 4 | 3.32 | 0.66 | 2.7* |
| Linkage to local service providers | 198 | 1 | 4 | 3.28 | 0.59 | 2.7* |
| Experienced local design teams | 199 | 1 | 4 | 3.29 | 0.74 | 2.5* |
| Experienced local contractors | 199 | 1 | 4 | 3.22 | 0.73 | 2.5* |
| Local labour | 199 | 1 | 4 | 3.07 | 0.76 | 2.3 |
| Valid N (listwise) | 198 | | | | | |

*Note:* 1 = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; * = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

Table 4
*Descriptive statistics of the importance of criteria under the TBL Sub-Issue ($N_{all}$ = 203) – Example of how the criteria for "Triple Bottom Line Accounting" were selected*

| TBL: Triple Bottom Line Accounting – Planet, People, Profit | | | | | | |
|---|---|---|---|---|---|---|
| Criteria | N | Min | Max | Mean | SD | Min. Mean (Mean – SD) |
| Practice of referring to EIA report | 201 | 2 | 4 | 3.42 | 0.61 | 2.8* |
| Assess quality of workmanship | 198 | 2 | 4 | 3.39 | 0.61 | 2.8* |
| Consider both capital and long-term operation costs | 200 | 1 | 4 | 3.37 | 0.60 | 2.8* |
| Conduct Triple Bottom Line | 200 | 1 | 4 | 3.28 | 0.64 | 2.6* |
| Conduct Design Risk Analysis | 200 | 2 | 4 | 3.26 | 0.67 | 2.6* |
| Payback period | 202 | 1 | 4 | 3.12 | 0.71 | 2.4 |
| Rate of occupancy and occupancy turnover | 201 | 1 | 4 | 3.10 | 0.67 | 2.4 |
| Valid N (listwise) | 193 | | | | | |

*Note: 1* = Not important and can be omitted; 2 = Less important and may be omitted; 3 = Important and should be assessed; 4 = Very important and must be assessed; * = Selected for the MOBSA framework (Mean - SD ≥ 2.5)

What needs to be highlighted here is that ‘Social’ and ‘Environmental’ issues were weighted as “High” (RII of 0.73 and 0.75 respectively), while ‘Economic’ issue was rated as “Medium” (RII of 0.60). This shows that stakeholders of this study considered all three aspects important for the framework. From 120 criteria identified in, the qualitative phase, only 88 were eligible to be tested and validated because they recorded a higher mean value than assigned by the study.

### Phase 3: Integration of Qualitative and Quantitative Results

Both qualitative and quantitative results were integrated to propose performance benchmarks for all selected criteria. Typically, BPASs use performance benchmarks as the basis to measure and indicate how well a case study building is performing, or likely to perform. Therefore, each benchmark is normally assigned with a number of points in order for the overall performance score of a case study building to be calculated.

Benchmarks can be derived theoretically, empirically and by expert opinion. According to Hyde et al. (2007), validity and robustness of the approaches to defining benchmarks are of paramount importance. He asserted that ‘triangulation’ methodology by using a combination of data sources should be used to derive information for creating valid benchmarks. This study attempts to use a combination of approaches. The performance benchmarks proposed by the experts in the focus groups were used. Most of the context-specific benchmarks proposed by the focus groups were immediately adopted while others were further refined based on literature and interview data (i.e. theoretically and by expert opinion). References or adaptations from foreign sources were treated with caution.

The results were subsequently presented to nine experts for validation, comprising three architects, three government officials, one engineer, one facility manager, and one contractor. They were asked to examine the reliability of the criteria benchmarks for current practice. Consequently, the resulted modifications were presented as the *Validated Comprehensive MyOBSA framework*, now only consisting of 86 criteria which were subsequently integrated with a scoring system – proposed based on their important level derived in the quantitative phase – to enable its application in real life.

The calculation of weighting value of each issue, however, does not solely depend on its important level derived in the quantitative phase, due to the fact that the weighting values differ slightly from results obtained from the qualitative phase. It should be noted that the results from both data collections indicate that ‘Environmental’ and ‘Social’ issues are deemed to be slightly more important than ‘Economic’ issues. Results are shown in Table 5. With regard to the sub-issues, their weightings were assigned using the same scale system used to reflect the important level of each criterion; for example, sub-

Table 5
*Proposed weightings for sustainability Issues of the MyOBSA Framework*

| | | Mean | | | | |
|---|---|---|---|---|---|---|
| Sustainability Issues | Code | Interview (Phase 1)[a] | Questionnaire (Phase 2)[b] | Average Mean | Proposed Weightings[c] | Important Level[d] |
| Social | S | 3.7 | 3.5 | 3.6 | 34.3% | H |
| Environmental | EN | 3.6 | 3.6 | 3.6 | 34.3% | H |
| Economic | EC | 3.5 | 3.1 | 3.3 | 31.4% | M |
| Total | | | | 10.5 | 100% | |

*Note.*
[a]$N_{all}$ = 30
[b]$N_{all}$ = 203
[ab]1 = Not important; 2 = Moderately important; 3 = Important; 4 = Very important
[c]Proposed weighting value for each Issue is calculated as the average mean value of that Issue divided by the total average mean values of all Issues multiplied by 100. For example, the proposed weighting value for "Social" Issue was calculated as (3.6/10.5) x 100 = 34.3%
[d]The important level of each Issue is brought here from the Stage-3 MyOBSA framework. H = high and M = medium

issue with high important level is assigned with 3 points, medium with 2 points, and low with 1 point. Results are shown in Table 6.

### Phase 4: Results from the Case Study

Finally, the *Validated Comprehensive MyOBSA Framework* was applied on an environmentally-certified local case study building project (Shari & Soebarto, 2012b); hence, forming the basis to further refine the criteria, benchmarks and weightings empirically. The purpose of this application is to demonstrate the framework's appropriateness to the local context, given the potential risk of lack of input data or difficulties in obtaining them to complete the assessment. This is due to the fact that poor data acquisition can erode the rigour of the benchmarking process (Hyde, et al., 2007). Therefore, it was anticipated that the whole processes involved in proposing appropriate local performance benchmarks would improve the robustness of the framework, if adopted in reality.

It is important to highlight that the *Validated Comprehensive MyOBSA Framework* consists of four smaller frameworks that were formulated to be applicable for a specific phase of assessment: 1) *MyOBSA for the Pre-Design Phase*; 2) *MyOBSA for the Design Phase*; 3) *MyOBSA for the Construction and Commissioning Phase*; and 4) *MyOBSA for the Operation Phase*. For the purposes of demonstrating the proposed framework , this study focused only on the *MyOBSA Framework for the Design Phase*, which contains the majority of the criteria in the *Validated Comprehensive MyOBSA Framework*. The framework was applied by doing an assessment of the project using archival data available at the end of the design stage, including tender/

Table 6
*Proposed weightings for sustainability Sub-Issues of the MyOBSA Framework*

| Sub-Issues | Important Level[a] | Scale | Proposed Weightings[b] | Net Weightings[c] |
|---|---|---|---|---|
| S: Social | | | 34.3% | |
| EDU: Education & Awareness | H | 3 | 18.2% | 6.24% |
| COH: Support for Social Cohesion | M | 2 | 12.1% | 4.15% |
| ACC: Accessibility | H | 3 | 18.2% | 6.24% |
| INC: Inclusiveness of Opportunities | M | 2 | 12.1% | 4.15% |
| HUM: Human Health & Well-being | H | 3 | 18.2% | 6.24% |
| CUL: Cultural & Heritage Aspects | M/L | 1.5 | 9.1% | 3.12% |
| LOC: Local People & Employment | M | 2 | 12.1% | 4.15% |
| Total EDU+COH+ACC+INC+HUM+CUL+LOC | - | 16.5 | 100% | 34.3% |
| EN: Environmental | | | 34.3% | |
| ECO: Land Use & Impacts on Ecology | H | 3 | 15% | 5.15% |
| SRM: Supports Resource Management | M | 2 | 10% | 3.43% |
| AIR: Emissions to Air | H | 3 | 15% | 5.15% |
| LAN: Emissions to Land/ Solid Waste | H | 3 | 15% | 5.15% |
| EWA: Emissions to Water | H | 3 | 15% | 5.15% |
| ADJ: Impacts on Adjacent Properties | M | 2 | 10% | 3.43% |
| ENE: Non-Renewable Energy Consumption | M | 2 | 10% | 3.43% |
| WAT: Potable Water Consumption | M | 2 | 10% | 3.43% |
| Total ECO+ SRM+AIR+LAN+EWA | - | 20 | 100% | 34.3% |
| EC: Economic | | | 31.4% | |
| TBL: Triple Bottom Line Accounting | M | 2 | 40% | 12.56% |
| EEF: Efficiency, Effectiveness & Flexibility | H | 3 | 60% | 18.84% |
| Total TBL+EEF | - | 5 | 100% | 31.4% |
| Innovation | N.A. | | N.A. | N.A. |

*Note:*
[a]The important level of each sub-issue is brought here from the Stage-3 MyOBSA framework. H = high; M = medium; L = low.
[b]Proposed weighting value for each Sub-Issue is calculated as the scale value of that Sub-Issue divided by the total scale values of all Sub-Issues within an Issue multiplied by 100. For example, the proposed weighting value for EDU Sub-Issue was calculated as (3/16.5) x 100 = 18.2%. Weightings should be adjusted to ensure that the total weighting of all active/applicable Sub-Issues within each Issue is always 100%.
[c]Net weighting value for each Sub-Issue is calculated as the proposed weighting of that Sub-Issue multiply by the proposed weighting of the relevant Issue of which the Sub-Issue is fall under. For example, the net weighting value for EDU Sub-Issue was calculated as 18.2% x 34.3% = 6.24%.

contract documents, and reports related to the building design. Inputs from four key project stakeholders were sought and any difficulties in obtaining input data to complete the assessment were identified.

For fassessing the qualitative criteria such as management, process, and communication, the stakeholders were requested to select the appropriate points that should be awarded for the respective criteria being investigated. In this manner performance criteria and benchmarks that needed adjustment could be identified. In addition, they also received a few quantitative criteria assessed and scored by the researcher for verifications and comments.

Overall, it was found that all the criteria within the framework are most likely to be assessable and realisable with limited risk of data availability and completing the assessment, with an exception of "Increase use of materials that have less environmental impact in producing them". Currently, the development of local and comprehensive data on materials and their environmental impact in Malaysia is at its infancy; however, based on the sensitivity analysis it was found that this criterion is unlikely to be a crucial component of the MyOBSA framework, at least for the time being.

## DISCUSSION: THE VALIDATED COMPREHENSIVE MYOBSA FRAMEWORK

Table 7 shows the *Validated Comprehensive MyOBSA framework* consisting of issues, sub-issues, applicable criteria by phase of assessment, and their spatial scale. Due to the length of this framework, performance benchmarks of each criterion have not been included here. For the complete version of the *Validated Comprehensive MyOBSA Framework* or individual *MyOBSA Framework for the Pre-Design, Design, Construction & Commissioning*, and *Operation Phases*, refer to Shari (2011). The nature and form of the framework is discussed below based on its fulfilment of five main requirements identified in Shari and Soebarto (2015).

### Requirement 1: Embracing Sustainability Concept and Addressing Priorities of Emerging/Developing Countries

Overall, the framework evaluates stakeholders' decisions in the building and construction processes in relation to the complex concept of sustainability by taking into account the interrelationship of environmental (indicated in terms of environmental loadings or impacts during the building life cycle), social (indicated in terms of building's interaction with sustainability concerns on community-level) and economic (indicated by monetary flows connected to the building during its life cycle) aspects of sustainable development. It is structured hierarchically in three levels, with the higher level logically derived from the lower ones: 3 sustainability issues (i.e. 'Environment', 'Social' and 'Economic'), 17 sub-issues and 86 criteria (a mixture of quantitative and qualitative types).

By having a broad scope of assessment, the framework is able to address non-environmental priorities of emerging/developing countries. These priorities are: 1) to promote participation among stakeholders, and enhance their knowledge and awareness in supporting sustainability throughout the life cycle of their project;

Table 7
*Validated comprehensive MyOBSA framework (without performance benchmarks) – Applicable criteria by phase of assessment and their spatial scale*

| Social Sub-Issue | Spatial Scale | Criteria | Applicable criteria by phase | | | |
|---|---|---|---|---|---|---|
| | | | P-Dsn | Dsn | C&C | Ops |
| Education & Awareness | O | Awareness of building occupants | | | | ■ |
| | O | Readiness & competency of design team | ■ | ■ | | |
| | O | Skills & knowledge of maintenance & operation staff | | ■ | ■ | ■ |
| | O | Skills among construction workers | | ■ | ■ | |
| Support for Social Cohesion | O | Inter-disciplinary work | ■ | ■ | | |
| | C | Support active streetscape | ■ | ■ | | ■ |
| | B | Space planning for maximum social interaction | ■ | ■ | | ■ |
| | O | Participation of affected community | ■ | | ■ | |
| | O | Participation of users | ■ | ■ | | |
| Accessibility | B | Personal safety & security | ■ | ■ | ■ | ■ |
| | B | Maintenance access for building facades | ■ | ■ | | ■ |
| | B | Access to communication technology | ■ | ■ | | ■ |
| | B | Maintenance access for building services installations | ■ | ■ | | ■ |
| | C | Access to nearby services | ■ | ■ | | |
| Inclusiveness of Opportunities | B | Universal access | ■ | ■ | | ■ |
| | B | Facilities for users to perform religious obligations | ■ | ■ | | ■ |
| | B | Facilities for users with children | ■ | ■ | | ■ |
| Human Health & Well-being | B | Avoid construction accidents | | ■ | ■ | ■ |
| | B | Level & quality of fresh air | ■ | ■ | | ■ |
| | B | Openings & cross ventilation | ■ | ■ | | ■ |
| | B | Noise level & acoustic performance | ■ | ■ | | ■ |
| | B | Illumination level & quality of artificial lighting | ■ | ■ | | ■ |
| | B | Prohibit tobacco smoking | ■ | ■ | ■ | ■ |
| | B | Low/zero pollutants cleaning & maintenance | ■ | | ■ | ■ |
| | B | Interior finish materials with low/zero off-gassing | ■ | ■ | | ■ |
| | B | Air movement for thermal comfort | ■ | ■ | | ■ |
| | B | Glare conditions | ■ | ■ | | ■ |
| | B | Building flush-out | ■ | ■ | ■ | ■ |

Table 7 *(continue)*

| | | | | | | |
|---|---|---|---|---|---|---|
| | B | Areas/rooms which generate pollutants & odour | ■ | ■ | | ■ |
| | B | Monitoring of occupants' satisfaction with IEQ | ■ | | | ■ |
| Cultural & Heritage Aspects | B | Heritage significance of the building or adjoining/nearby heritage buildings | ■ | ■ | ■ | ■ |
| Local People & Employment | C | Training opportunities for unskilled local people | | | ■ | |
| | C | Locally available materials & products | ■ | ■ | | |
| | C | Local service providers | | | | ■ |
| | C | Experienced local design teams | | ■ | | |
| | C | Experienced local contractors | | ■ | ■ | |

| Environmental Sub-Issue | Spatial Scale | Criterion | Applicable criteria by phase | | | |
|---|---|---|---|---|---|---|
| | | | P-Dsn | Dsn | C&C | Ops |
| Land Use & Impacts on Ecology | S | Damage to soil, water bodies, and flora & fauna | ■ | ■ | ■ | |
| | S | Landscape spaces on the site | ■ | ■ | | ■ |
| | S | Ecological value of natural landscape | ■ | ■ | | ■ |
| | C | Risk of flooding | ■ | ■ | | |
| Supports Resource Management | G | Materials that have less environmental impact** | ■ | ■ | | |
| | B | Building design for maximum durability | ■ | ■ | | |
| | B | Bio-based products & materials | ■ | ■ | ■ | ■ |
| | B | Materials that can be recovered or recycled | ■ | ■ | | |
| | B | Products & materials with recycled content | ■ | ■ | ■ | ■ |
| Emissions to Air | C | Access to basic services & connection to public transportation network | ■ | ■ | | ■ |
| Emissions to Land/ Solid Waste | S | Handling & storage of hazardous wastes on site | ■ | ■ | | ■ |
| | B | Construction waste management programme | ■ | ■ | ■ | |
| | B | Spaces for collection of recyclables | ■ | ■ | ■ | ■ |
| | B | Recycling of office recyclables | ■ | ■ | | ■ |
| | S | Pollution from site workers' accommodation | ■ | | ■ | |
| | B | Standardized & prefabricated components | ■ | ■ | ■ | |

Table 7 *(continue)*

| | | | | | | |
|---|---|---|---|---|---|---|
| Emissions to Water | C | Stormwater management strategies | ■ | ■ | ■ | |
| | C | Pollution from site workers' accommodation | ■ | | ■ | |
| | S | On-site wastewater treatment systems | ■ | ■ | | ■ |
| Impacts on Adjacent Properties | C | Noise & vibration generated during construction | ■ | ■ | ■ | |
| Non-Renewable Energy Consumption | B | Energy efficient light fixtures & office appliances | ■ | ■ | | ■ |
| | B | Efficient ventilation & air-conditioning systems | ■ | ■ | | |
| | B | Passive cooling strategies | ■ | ■ | | |
| | B | Integrated lighting concept | ■ | ■ | | ■ |
| | B | Fossil fuel energy consumption for operations | ■ | ■ | | ■ |
| | B | Size of building systems control zones | ■ | ■ | | ■ |
| | B | Automatic lighting control systems | ■ | ■ | | ■ |
| | B | Energy sub-metering system | ■ | ■ | | ■ |
| | B | Personal control of the thermal comfort systems | ■ | ■ | | ■ |
| Potable Water Consumption | S | Harvest rainwater | ■ | ■ | ■ | ■ |
| | B | Water efficient plumbing fixtures & appliances | ■ | ■ | | ■ |
| | S | Potable water for landscaping irrigation | ■ | ■ | | ■ |
| | B | Potable water for cooling system | ■ | ■ | | ■ |
| | B | Water meters | ■ | ■ | | ■ |
| Economic Sub-Issue | Spatial Scale | Criterion | Applicable criteria by phase | | | |
| | | | P-Dsn | Dsn | C&C | Ops |
| Triple Bottom Line Accounting | C | Referring to EIA report | ■ | ■ | | |
| | B | Quality of workmanship | | | ■ | |
| | B | Capital cost & long-term operational costs | ■ | ■ | | |
| | O | Triple Bottom Line | ■ | ■ | | |
| | O | New & untested sustainable products & technologies | ■ | ■ | | |
| Efficiency, Effectiveness & Flexibility | B | Long-term maintenance management plan | ■ | ■ | | ■ |
| | B | Building management control system | ■ | ■ | | ■ |
| | O | Comprehensive building records | ■ | ■ | ■ | ■ |
| | B | Spatial flexibility | ■ | ■ | | |

Table 7 *(continue)*

| | | | | | | |
|---|---|---|---|---|---|---|
| | B | Building services systems with maximum flexibility | ■ | ■ | | |
| | B | Comprehensive commissioning | ■ | ■ | ■ | ■ |
| | B | Structural and core layout with maximum adaptability | ■ | ■ | | |
| | B | Floor-to-floor height for high level of functionality | ■ | ■ | | |
| | B | Directly functional area to total floor area ratio | ■ | ■ | | |
| | | Criterion | | | | |
| Innovation | O | Innovative strategies and technologies | | ■ | ■ | ■ |
| | O | Exceeding MOBSA benchmarks | | ■ | ■ | ■ |

*Note:*
Assessment Phase: P-Dsn = Pre-design phase; Dsn = Design phase; C&C = Construction & Commissioning phase; Ops = Operations phase
Spatial Scale:
G = Global level: *Impacts on resources specifically identified to be global*;
C = Community and regional level: *Impacts on the neighbourhood, community and region*;
S = Site level: *Site-specific attributes*;
B = Building level: *Certain construction techniques, attributes of buildings, or types of building materials*; and
O = Other: *Criteria that do not fit the above*.

2) to increase participation of affected community in development process; 3) to improve human health and well-being; 4) to improve efficiency, safety of processes and quality of products; 5) to ensure affordability; 6) to ensure social equity and cohesion; and 7) to utilize semi-skilled labour. On top of these, the framework also incorporates environmental priorities of emerging/developing countries such as: 1) reducing energy consumption and air pollution; 2) promoting solid waste reduction, recycling and safe disposal; and 3) improving access to public transportation.

**Requirement 2: Acknowledging the Local Context**

The first aspect of the framework that acknowledges the local context is its selected performance criteria. For example, among the selected performance criteria that reflect Malaysian priorities are: 1) efficient use of resources; 2) controlled and planned development; 3) use local materials; 4) reduce work accidents; and 5) consider both capital cost along with operational costs. The framework also excludes certain criteria that are currently too difficult to assess either due to local conditions and constraints (e.g.

provide minimum allowable parking spaces, and use black water treatment systems) or the unavailability of relevant data to complete the assessment (i.e. embodied energy of building components/materials).

The second aspect of the framework that reflects the local context is the proposed weightings. Based on the research findings, all the 3 sustainability issues ('Environment', 'Social' and 'Economic') were given almost equal weightings, meaning that in the study, the stakeholders value each of these issues as important as the others. This result is in tandem with the local conditions argued in Shari and Soebarto (2015): the necessary balance between the socio-economic and ecological systems to avoid further environmental damage has not yet been reached in the country.

**Requirement 3: Linking Across Varying Spatial Scales**

The spatial scale at which a criterion is assessed defines the spatial boundary separating outcomes that will and will not be considered. For example, an assessment criterion may have an impact at a building, site, on the community or even region and world as a whole. Out of 86 criteria within the MyOBSA framework, 16% assess aspects at the scale broader than the site level i.e. global and community levels, 70% assess aspects at site and building levels, and the remaining 14% are related to administrative and communication/process. It is worth noting that the percentage of 16% criteria at the community/regional and global levels is significantly higher than the percentage in the Singapore's Green Mark (4%), China's Three Star System (8%), and Malaysia's GBI (11%) and comparable with other BPASs reviewed in Shari and Soebarto (2015).

**Requirement 4: Addressing all Building Lifecycles and Incorporating Both Potential and Actual Performance Assessments**

Although the application of the framework as shown in this paper only focuses on the design stage, in principle the issues are relevant to all phases of a life cycle of a building, including pre-design, design, construction and commissioning, and operation phases. This in turn informs the anticipated stakeholders for each of them.

Appropriate benchmarks are also available for each criterion to suit its applicable phase(s) of assessment. For instance, for pre-design phase assessment, evidence is required to show that the required performance is included in the client's project brief. Whilst, for design phase, evidence is required to show that the design conforms to or exceed the criterion's benchmarks. For operation phase assessment however, evidence is required to show that the building has actually performed as was intended.

This way, the framework assesses both potential performance (i.e. design-based criteria such as potential energy consumption) and actual performance (performance-based criteria such as actual energy consumption and post occupancy evaluation). As highlighted by Hyde et al. (2007, p.558), "it is important that benchmarking becomes more strategic, that is, based on a number of sources of information drawn from both design and operation conditions" and "the method of validating performance is a crucial indicator of rigour, since it establishes the credibility of the standard" (Hyde, et al., 2007, p.554).

### Requirement 5: To Involve Participation of Local Building Stakeholders

As evidenced in the methodology, stakeholders' participation through communication, dialogue, commitment and cooperation was taken into consideration in all phases of the study to ensure the MyOBSA framework is accepted by the market and supported by industry.

### Notes About the Study

Although the research has generally achieved the specific objective stated in the introduction, it nevertheless had its limitations. Firstly, the size of the sample was limited to 203; hence, it is acknowledged that the final selected criteria or indicators might be different if the sample size was different or larger covering larger demographic areas. Further, the sample size obtained for the qualitative study is only adequate to enable internal generalization i.e. 30; hence, findings may not be employed to make inferences on other construction industry stakeholders not included in the study.

Secondly, the survey is confined to two out of three federal territories (i.e. Kuala Lumpur and Putrajaya) and one out of thirteen states (i.e. Selangor) in Malaysia. Despite the fact that Malaysia has no different climatic zones, certain parts of the country are drier or wetter than others depending on the months of the year. Other variations include nature, socio-economic background and priorities, and technical achievements. Therefore, the weightings developed in this survey are possibly applicable to states or cities that are similar to the investigated ones. Otherwise, further research needs to be conducted to generate appropriate weightings for other states or cities. Further, the results of the weighting exercise are inevitably subjective and are time-dependent; hence, will require regular updating.

Thirdly, the research is confined to office building projects. However, the findings from this study can be considered as a guide to assess and develop sustainable building criteria for other building typologies in the Malaysian context.

Fourthly, this paper only shows the applicability of the criteria relevant to the design phase of assessment. This means, performance benchmarks defined for criteria relevant to other phases of assessment may require adjustments due to data unavailability or difficulties in obtaining them to complete the assessment.

Finally, it is considered a building industry's prerogative to determine the different levels of "rating" to be awarded and the minimum score that should be achieved for each rating level of MyOBSA;

hence, assigning different levels of "rating" is beyond the scope of this study. It is also worth pointing out that these aspects are not standardized among existing BPASs. For instance, Green Mark sets as high as 90 out of 100 for its "Platinum" rating; whereas Malaysia GBI and UK BREEAM settle on slightly lower minimum score of 86 for "Platinum" and 85 for "Outstanding" ratings respectively. Interestingly, other BPASs that agree on even lower minimum scores than aforementioned are LEED-US (80 for "Platinum" rating) and Australia Green Star (75 for "6-Stars" rating).

## CONCLUSION AND RECOMENDATIONS

This paper has presented the development of appropriate assessment framework that enables sustainability to be addressed and incorporated in office building development in emerging/developing countries such as Malaysia. . The MyOBSA framework was presented, discussed, refined, and finally verified and tested in the research using a real-life case study office building. The multiple stages involved in deriving the final MyOBSA framework in general, or the appropriate performance criteria and benchmarks in particular, have improved the robustness of the MyOBSA framework. The key point is that the framework and key performance criteria identified in this study will improve the understanding of practitioners by promoting comparisons, discussions, and learning. Also, the developed framework is found to be able to consider different levels of information and to structure all relevant issues in an ordered manner, helping decision makers handle the multiplicity of the issues embodied in the concept of sustainability.

It is anticipated that in the future, the performance standards of office buildings in Malaysia would rise (more buildings become 'greener' or the baseline improves); therefore, over time, regulations would be updated, sustainable technologies, local capabilities and understanding of issues would evolve, and sustainable building performance may be improved. In fact, it should be noted that the proposed benchmarks in this study are by no means definitive or conclusive. If this framework were to be adopted, it is recommended for the performance benchmarks defined in the MyOBSA framework to be gradually revisited or updated over time. As many of the benchmarks are context dependent, they should also be adjusted if adopted in different areas or regions. Adjustments should also be made to weightings and scoring in response to changing priorities. Nevertheless, the weightings developed in this study can provide valuable references and be useful at least in two ways: 1) as a reference when applying weighting system in any BPAS in Malaysia; and 2) as a guide for the Malaysia specific sustainable building researchers and practices to focus on the more important issues.

Assessment criteria included in the *Validated Comprehensive MyOBSA Framework* must be extended as and when the severity of certain issues become more acute and of political and public concern. This process will not only facilitate the necessary integration of issues, perspectives and views in building assessment but also facilitate participation and transfer of knowledge among stakeholders. Above all, it is recommended that further research be conducted to develop a Malaysia-specific building sustainability assessment framework for other building types such as schools and campuses (as well as a country-specific building sustainability assessment framework in other developing or emerging countries), by adopting the processes and experience resulting from developing this MyOBSA framework.

## ACKNOWLEDGEMENTS

The paper presents the main results of the first author's completed doctoral research at the University of Adelaide, sponsored by the Ministry of Education Malaysia and Universiti Putra Malaysia. The authors are especially thankful for the contribution by Adjunct Associate Professor Terence Williamson, who co-supervised this research.

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